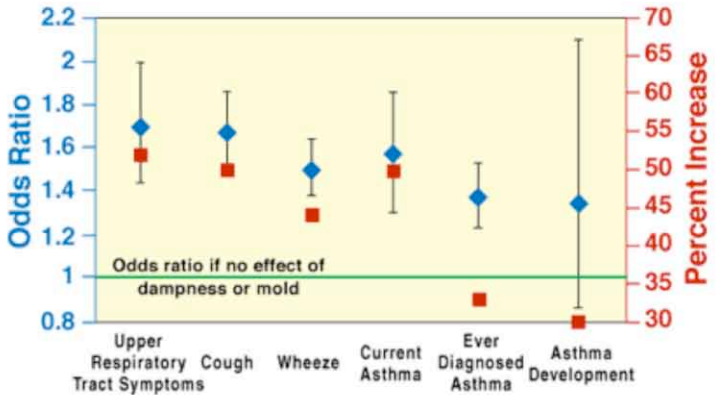
Impacts of Indoor Environmental Quality on Health, Comfort and Performance

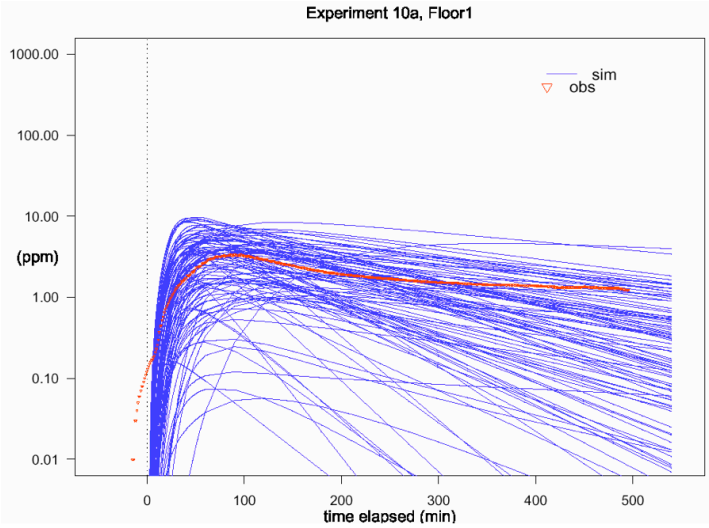


Knowledge of the relationship between indoor environmental quality and people's health, comfort, and performance provides the critical foundation for ventilation and indoor air quality standards and for many decisions about how to design, operate, use, and maintain buildings. To assess how the indoor pollutants, thermal conditions, and related features of buildings affect health, work performance, school performance, and school absence, the Department performs epidemiologic studies and experiments in buildings and completes critical reviews and meta-analyses of existing data.

Life-Cycle Impact Assessment

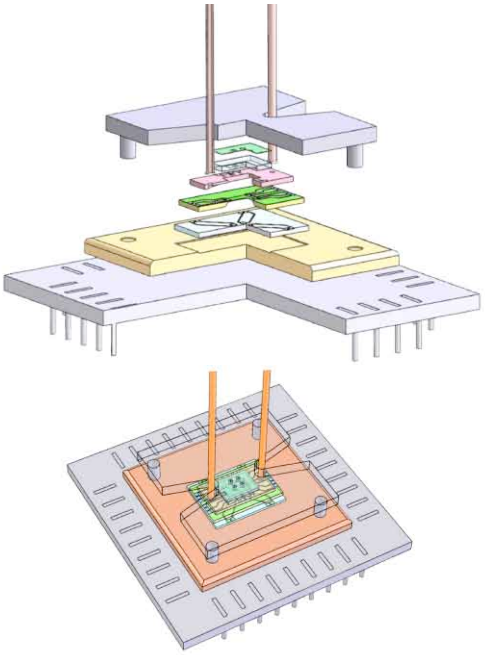
Life-cycle assessment addresses a broad range of impacts for technologies, industrial processes, and products in order to determine their propensity to consume natural resources or generate pollution. The term "life cycle" refers to the need to include all stages of a product or service—raw material extraction, manufacturing, distribution, use, and disposal. A life-cycle impact assessment (LCIA) provides characterization factors to compare the impacts of different product/service components. The Department's research program is developing methods to study the life-cycle health and environmental impacts, as well as economic feasibility and performance of the various pathways from sunlight to energy, with a current emphasis on biofuels. The department is also assessing the environmental, economic, and health consequences of the construction, operation, and end-of-life treatment of buildings. A particular emphasis is on the improved knowledge of the interactions and potential trade-offs among economic, environmental, and health burdens linked to commercial and residential building energy performance and the environmental and economic impacts of building materials through the associated supply chains and building-use phase.

Statistical Data Analyses



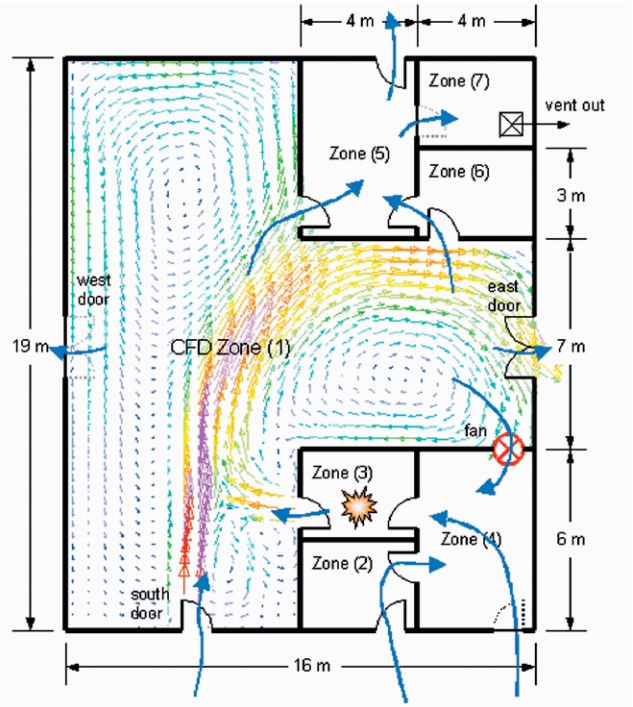
Data analysis, model uncertainty propagation, and decision analysis are integral components of the Department's research. We have developed innovative tools for analyzing data from experiments, propagating uncertainties of model inputs to output predictions, and decision making when faced with uncertain outcomes. Computational tools applied include Bayes Monte Carlo uncertainty analysis, conditional and regression trees, value-of-information analyses, and various multivariate and meta-analysis techniques. Recent applications include explaining data from various observational and field experiments, epidemiological studies (e.g., the effects of dampness and mold on health), and environmental pollutant fate predictions.

Sensors and Sensor Networks



The Department develops and evaluates sensors for various environmental and energy applications. Examples of related research include refining and miniaturizing a personal particle exposure monitor, evaluation of the accuracy of carbon dioxide sensors used for control of building ventilation, and evaluation of sensor systems that determine the number of occupants in a building or building zone, which may be used to prescribe the amount of ventilation needed to maintain indoor air quality. The Department also has active research programs in designing environmental sensor networks and interpreting measurements from them. For example, we have a program on interpreting readings from various building sensors (energy, temperature, CO_2, etc.) to detect when and where a building energy system is operating properly or faulting. We also have a program to develop probabilistic algorithms to determine the optimal placement of air monitoring sensors to detect and locate a pollutant release in a building.

Modeling



Mathematical and statistical modeling are essential components of the Department's research. The Department holds an important scientific philosophy in how models are developed and employed in our research. In a nutshell, the complexity of a model should be regulated by the research question being explored. Questions we ask ourselves when developing models include "What level of detail is needed to answer this question? What are the model-input uncertainties and variability? What data exist to confirm or refute the model predictions? Our scientists sit on various National Academy and U.S. Environmental Protection Agency Science Advisory Panels to provide guidance on the appropriate use of models for environmental studies and regulatory purposes. Models used in our research include multimedia environmental fate and exposure models, building multi-zone airflow and pollutant dispersion models, computational fluid dynamics models, and various statistical and regression models.

Codes, Standards, and Guidelines

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Codes, standards, and guidelines are important tools for changing industry practice in a manner that improves environmental quality and reduces energy consumption. The Department provides extensive technical input to organizations responsible for codes, standards, and guidelines. In many cases, Department staff provide the initiative and leadership for the development of new professional consensus standards and guidelines by organizations such as the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) and the American Society of Testing and Materials.